Computer Architecture

Some questions & answers

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Q25

- List three broad classifications of external (or peripheral) devices.

A25

- **Human readable**:
  - Suitable for communicating with the computer user.
- **Machine readable**:
  - Suitable for communicating with equipment.
- **Communication**:
  - Suitable for communicating with remote devices

Q26

- Given x = 0101 and y = 1010 in 2s complement notation (i.e., x = 5, y = -6), compute the product p = x × y with Booth's algorithm.

A26

A	Q		M	
Initialization:	$Q_3Q_2Q_1Q_0$	Q_{-1}		
0000	1010	0	0101	Initial values
1st cycle:				
0000	0101	0	0101	AShiftr
2nd cycle:				
1011	0101	0	0101	A□A-M
1101	1010	1	0101	AShiftr
3rd cycle:				
0010	1010	1	0101	A□A+M
0001	0101	0	0101	AShiftr
4th cycle:				
1100	0101	0	0101	A□A-M
1110	0010	1	0101	AShiftr

Result is in A and Q

Q27

- Given x = 1001 and y = 0010 in twos complement notation (i.e., x = -7, y = 3), compute the division p = x / y .

A27

Accumulator	Quotient	Mdivisor	
$A_3A_2A_1A_0$	$Q_3Q_2Q_1Q_0$	$M_3M_2M_1M_0$	Divident is in A and Q
1111	1001	0011	Initial values
1st cycle:			
1111	0010	0011	LShiftl
0010	0010	0011	A□A+M (if $A_3 \neq M_3$)
1111	0010	0011	Restore A, Q_0□0 (if A ≠ 0)
2nd cycle:			
1110	0100	0011	LShiftl
0001	0100	0011	A□A+M (if $A_3 \neq M_3$)
1110	0100	0011	Restore A, Q_0□0 (if A ≠ 0)
3rd cycle:			
1100	1000	0011	LShiftl
1111	1000	0011	A□A+M (if $A_3 \neq M_3$)
1111	1001	0011	Q_0□1 (if $A_{3a} = A_{3b}$)
4th cycle:			
1111	0010	0011	LShiftl
0010	0010	0011	A□A+M (if $A_3 \neq M_3$)
1111	0010	0011	Restore A, Q_0□0 (if A ≠ 0)

Remainder is in A and quotient in Q

Q28

- In a computer system, address 100 contains decimal value 32, address 200 contains decimal value 10.
- What would be the contents of accumulator after running the following assembler code.
- Explain what happens.
  - LOAD 100
  - SHIFTR
  - SHIFTR
  - ADD 200

A28

- If address 100 contains 32, address 200 contains 10:

Instruction	*Acc. Content*	*Operation*
LOAD 100	A=32	A ☐ M(100)
SHIFTR	A=16	A ☐ A/2
SHIFTR	A=8	A ☐ A/2
ADD 200	A=18	A ☐ A+M(200)

Q29

- In a computer system, a small part of memory is given in the following table. What would be the contents of accumulator after running the following assembler code. (All values are in hexadecimal).

Mem. Adress	Data
A0	A4
A1	A3
A2	22
A3	3A
A4	A1

- LOAD IMMEDIATE A1
- RROTATE
- ADD INDIRECT A4
- AND IMMEDIATE EA
- SUB DIRECT A2
- SHIFTL

A29

LOAD IMMEDIATE A1 $\quad Acc = (1010\ 0001)_2 = (A1)_{16}$

RROTATE $\quad Acc = (1101\ 0000)_2 = (D0)_{16}$

ADD INDIRECT A4 $\quad Acc = (1101\ 0000 + 1010\ 0011)_2$
$= (0111\ 0011)_2 = (73)_{16}$

AND IMMEDIATE EA $\quad Acc = (0111\ 0011\ AND\ 1110\ 1010)_2$
$= (0110\ 0010)_2 = (62)_{16}$

SUB DIRECT A2 $\quad Acc = (0110\ 0010 - 0010\ 0010)_2$
$= (0100\ 0000)_2 = (40)_{16}$

SHIFTL $\quad Acc = (1000\ 0000)_2 = (80)_{16}$

Q30

Given the following memory values and a one-address machine with an accumulator, what values do the following instructions load into the accumulator?

Word 20 contains 40;
Word 30 contains 50;
Word 40 contains 60;
Word 50 contains 70;

a. LOAD IMMEDIATE 20
b. LOAD DIRECT 20
c. LOAD INDIRECT 20
d. LOAD IMMEDIATE 30
e. LOAD DIRECT 30

A30

Word 20 contains 40; Word 30 contains 50; Word 40 contains 60; Word 50 contains 70;

a. LOAD IMMEDIATE 20
b. LOAD DIRECT 20
c. LOAD INDIRECT 20
d. LOAD IMMEDIATE 30
e. LOAD DIRECT 30

a. *20*

b. *40*

c. *60*

d. *30*

e. *50*

Q31

- If the last operation performed on a computer with an 8 bit word was an addition in which the two operands were 2 and 3, what would be the value of the following flags:
  - Carry flag
  - Zero flag
  - Overflow flag
  - Sign flag
- What if the operands were -1 (2's complement) and +1?

A31a

2 (8 bit) 00000010
3 (8 bit) 00000011
        00000101

Carry = 0

Zero = 0

Overflow = 0

Sign = 0

A31b

-1 (8 bit 2s Complement) 11111111
1 (8 bit 2s Complement) 00000001
1 00000000

Carry = 1

Zero = 1

Overflow = 0

Sign = 0

Q32

- Let the address stored in the program counter be designated by the symbol X1.
- The instruction stored in X1 has an address part (operand reference) X2. The operand needed to execute the instruction is stored in the memory word with addres X3.
- An index register contains the value X4.
- What is the relationship between these various quantities if the addressing mode of instruction is

  a. direct,

  b. indirect,

  c. indexed,

  d. PC relative?

A32

a. X3 = X2

b. X3 = (X2)

c. X3 = X2 + X4

d. X3 = X1 + X2 + 1

Q33

A PC-relative mode branch instruction is 3 bytes long. The address of instruction, in decimal, is 256028. Determine the branch target address if the signed displacement in instruction is -31.

A33

Recall that relative addressing uses the contents of the program counter, which points to the next instruction after the current instruction.

In this case, the current instruction is at decimal address 256028 and is 3 bytes long, so the PC contains 256031.

With the displacement of –31, the effective address is 256000.